The Relationship Between Early Learning Rates and Treatment Outcome For Children With Autism Receiving Intensive Home-Based Applied Behavior Analysis

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The present study suggests that initial learning rates of young children with autism receiving early, intensive, home-based behavioral intervention are moderately correlated with outcome variables after four years of treatment. 20 children with autism who had Childhood Autism Rating Scale scores between 37.5 and 58 and Vineland Adaptive Behavior Scales scores between 38 and 63 at the beginning of treatment were re-evaluated after 4 years of treatment through the Rutgers Autism Program. School placement follow-up data were also available after 4 years. Treatment data reflecting rate of initial acquisition of skills was significantly correlated with school placement, severity of autism symptomatology, and adaptive behavior profiles four years into treatment, with those children having faster early skill acquisition showing greater gains in adaptive functioning, fewer or less severe symptoms of autism, and less restrictive educational placements after 4 years. The data are consistent with previous research showing the impact of intensive ABA intervention and variability in outcomes associated with such intervention, and also lend support to other published findings that early learning rates are correlated with outcome.
Key Words: Early Behavioral Intervention, Home based Programs, Outcome, Learning Rates, Autism

The demonstration of the benefits of intensive applied behavior analytic programming for preschoolers with autism has been compelling (e.g., Anderson, Avery, DiPietro, Edward & Christian, 1987; Fenske, Zalenski, Krantz & McClannahan, 1987; Harris, Handleman, Gordon, Kristoff & Fuentes, 1991; Lovaas, 1987). Approximately 50% of children with autism participating in such programs have been shown to have significant increases in IQ and/or be placed in regular educational classrooms with little or no support. A number of researchers have documented that intensive behavioral intervention (i.e., 30-40 hours per week) begun before age 4 and lasting at least 2 years sometimes produces these dramatic effects, although studies vary in degrees of experimental control and treatment fidelity.

While some studies report that just under half of the children receiving 40 hours per week of 1:1 instruction achieved essentially normal educational and intellectual functioning (Lovaas, 1987; McEachin, Smith, & Lovaas, 1993; Perry, Cohen, & DeCarlo, 1995), slightly less dramatic improvements have been documented with less intensive (i.e., 20-25 hours per week) intervention (Birnbrauer & Leach, 1993, Andersen et al., 1987; Harris et al., 1991). It is important to note, however, that most of these children benefited from substantial gains in IQ scores, adaptive functioning, and language (Anderson et al., 1987; Harris et al., 1991). These early studies provide demonstrations of results achieved in both home programs (Lovaas, 1987, McEachin et al, 1993, Perry, Cohen & DeCarlo, 1995) and center-based programs (Birnbrauer & Leach, 1993, Andersen et al., 1987; Harris et al., 1991).

Following the initial reports of the success of ABA intervention, another model of service delivery emerged in which intensive ABA was provided in home settings with programs coordinated by parents. Previous studies utilizing a home-based model were coordinated and supervised by ABA professionals who, in addition to directing programming, hired staff and managed data. However, in the alternate home-based model, parents played a much more central coordination role: hiring staff, managing data and assisting in programming decisions with consultation from ABA professionals. Smith, Buch and Evslin-Gamby (2000) reported on the effectiveness of parent directed, intensive early intervention programs in the home. While 5 of 6 children rapidly acquired skills at the start of

treatment, only 2 improved on standardized tests at 2-3 year follow-up. These authors also noted that home instructors were less consistent than clinic employees in their implementation of teaching strategies. This study highlights some of the unique challenges to conducting intervention in a home-based setting and represents one of the few published reports of progress of children involved in home-based ABA directed by parents.

In addition to the impact of variables such as intensity, setting, or coordinator as described above, research indicates that there may be other factors that are significantly related to outcome. The age of initial intervention appears to be critically important, with a much higher likelihood of eventual enrollment in regular education classes if intervention begins prior to age 5 than at a later age (Fenske et al., 1985). Harris and Handleman (2000) found that both IQ at intake and age at intake were predictive of educational placement after discharge. Specifically, children who were 48 months or younger at intake were much more likely to be educationally placed in an inclusive setting after preschool.

Early learning rates have also been hypothesized to have predictive value in outcomes for young children with autism. Lovaas and Smith (1988) suggested that an Early Learning Measure would be more predictive of outcome than standardized instruments. Their Early Learning Measure is an instrument containing 40 instructions, divided evenly between receptive language, non-verbal imitation, verbal imitation, and expressive language. In their research, children's rate of acquisition of these items in the first four months of treatment was correlated with outcome (Lovaas & Smith, 1988). Specifically, verbal imitation and expressive labeling abilities were predictive of ultimate outcome. Similarly, Smith, Groen, and Wynn (2000) found that among other variables, initial acquisition of skills in basic curricular areas was related to outcome in an ABA program.

Weiss (1999) found that initial learning rates were predictive of changes in adaptive functioning, severity of autistic symptoms, and school placement two years into treatment within a home-based ABA model. The present study represents a follow-up assessment of those children who were involved in a home-based model of ABA instruction.

In the present study, early learning rates of young children with autism exposed to intensive home-based ABA treatment over a period of 4 years were compared to global indices of progress (i.e., in autistic symptoms and in functional skills). Though not a controlled investigation of predictors of treatment outcome, the current study presents descriptive clinical data regarding progress in young children with autism receiving intensive behavioral treatment. Relationship of progress to initial treatment learning rates is examined.

Method

Participants

Data from the entire caseload of the first author were examined. The caseload consisted of 19 boys and one girl with autism receiving intensive behavior analytic home-based intervention for 40 hours a week for approximately two years, with supplemental home-based instruction in years three and four. The 20 children all received services through the Rutgers Autism Program, a non-profit service agency directed by university faculty. The gender ratio in this sample was representative of the population of children served at the center (76 boys and 4 girls). The average age of children at the start of intervention was 41.5 months (range: 20 - 65 months). Thirteen of the 20 youngsters started intervention prior to age 4, and 19 of the 20 children began intervention before age 5. All parents of the children receiving services had contacted the Rutgers Autism and requested services.

All of the children had received the diagnosis of autism or PDD/NOS from independent qualified professionals (i.e., doctoral level psychologists, pediatric neurologists). In each instance, all

children were seen by at least two professionals who indicated that the child met DSM-IV criteria (American Psychiatric Association, 1994) for a pervasive developmental disorder of Autistic Disorder or PDD-NOS. Eighteen of the 20 children had independent diagnoses of autism, while the remaining two had diagnoses of PDD-NOS. None of these professionals were employees of Rutgers University or involved in the intervention in any way. In addition, an initial observational screening by the first author confirmed that each child met the DSM IV criteria (American Psychiatric Association, 1994) for Autistic Disorder or PDD-NOS. At the time of these diagnoses and at the onset of treatment, instruments such as the Autism Diagnostic Interview - Revised (ADI-R; Lord, Rutter & LeCouteur, 1994) or the Autism Diagnostic Observation Scale (ADOS; Lord, Rutter, DiLavore & Lisi, 2001) were not widely available or utilized.

Treatment

Intensity. All treatment was delivered within a home-based ABA model, with each student receiving approximately 40 hours per week of individual sessions with an instructor, for the first two years. During this time, the children generally received 6 hours of instruction per day, seven days a week. The 6 hours of daily instruction were divided into two 3-hour sessions. During the work sessions, instructional demands were interspersed with periods of naturalistic play. Children generally worked for 5 to 20 trials, and then played for 1 to 3 minutes. This pattern was repeated throughout the session.

In years three and four, 1:1 home-based instruction was in addition to school-based treatment. During this time, home-based hours averaged approximately 20 hours per week, delivered in 3-hour sessions each day after school and one or two 3-hour session each weekend.

Data was not available on the precise number of hours of instruction each child received per week. All families were advised to provide 40 hours of instruction per week. All parents logged hours and all parents reported that the children received about 40 hours per week throughout the two-year period, and approximately 20 hours per week in the last two years.

Programming and Curriculum. Specific details of the Rutgers Autism Program intervention model are described in depth elsewhere (Weiss & Piccolo, 2001) and therefore not addressed here. Programming utilized ABA teaching strategies such as shaping, Discrete Trial Instruction and naturalistic teaching strategies, and involved individualized use of reinforcement. Basic initial curricular targets for young children included early expressive and receptive language programs, imitation and matching skills, and beginning social skills such as requesting. Progression through programming was determined by data regarding the child's progress and individualized to reflect each child's strengths and specific deficits. Programming was coordinated by the first author, a doctoral level clinical psychologist with extensive experience using applied behavior analytic methods with children with autism. In some cases, a behavior specialist employed by the Rutgers Autism Program assisted in monitoring programming and providing consultation.

Instructors. All of the instructors were hired by the families to provide direct instruction. The prior experience and knowledge levels of instructors were variable. Many instructors were college students or graduates specializing in psychology or special education. Typically, each instructor was paired with an experienced instructor for 18 hours of training before working individually.

Training. Instructors were all trained in an initial two-day workshop and received additional training every 4 to 6 weeks. Workshop training was primarily conducted by the first author, with some additional workshops co-led by an experienced behavior employed by the Rutgers Autism Program. Initial workshop topics included: definitions of ABA terminology, basics in the technique of discrete trial instruction, use of reinforcement, and prompting strategies. Role-play, demonstration, and a

checklist of instructional competence in discrete trial instruction were used to provide practice, feedback, and evaluate competency. The child was present for the workshop and was worked with directly for the majority of the time. Follow-up training (every 4 to 6 weeks) afforded opportunities to hone complex clinical ABA techniques such as shaping, prompt fading, and incidental teaching.

Data. In all cases, instructional staff in the home-based program recorded data. Mastery of each program and each item within a program was always determined through trial-by-trial data collection. Mastery reflected 90% performance (out of a minimum of 10 trials) across two instructors in two consecutive sessions. Instructors determined mastery. Mastery dates were recorded for first and second mastery of each item. First mastery was the first instance of 90% or better performance, while second mastery was the second instance of performance at this level with a different instructor and in a consecutive session. Full mastery could take place on one day if first and second mastery occurred on the same day.

Procedures

Measures. All children were assessed with the Childhood Autism Rating Scale (CARS) (Schopler, Reichler, DeVellis & Daly, 1988) and the Survey Form of the Vineland Adaptive Behavior Scale (Sparrow, Balla & Cicchetti, 1984) at the start of intervention and at approximately two years and four years into treatment. The CARS consists of 15 subscales based on specific behavior observation and has generally good inter-rater reliability and discriminant validity based on DSM-IIIR criteria (Parks, 1983; Sevin, Matson, Coe, Fee & Sevin, 1991). The Vineland Adaptive Behavior Scales are widely used to assess developmental and self-help competencies in four domains: communication, socialization, daily living skills, and motor skills. Additionally, an adaptive behavior composite score provides a summary of comprehensive adaptive functioning (Harris, Delmolino & Glasberg, 1996). The first author administered these instruments. The Vineland and CARS for 12 of the children were re-administered independently by a master's level clinician at the Rutgers Autism Program. This clinician was not involved in the child's program and arranged for a separate interview within one week of the original interview. Both instruments are widely utilized in clinical settings to evaluate young children with autism and as measures of treatment outcome (e.g. Rogers & Lewis, 1989; Smith, Groen & Wynn, 2000).

Data regarding mastery of initial skills was obtained from archival records for each child. Data from seven initial programs were included in the analyses. These programs were selected because these were core components of initial programming for all children receiving intervention (see Table 1). The measure of initial skill acquisition used for each program was the average number of days to master each of the first five items.

Table 1. Initial Programs

1. **NVI (Non-Verbal Imitation) SD**: "Do this"
   Sample items: stomp feet bang table
   clap hands raise arms
2. **OM (Object Manipulation) SD**: "Do this"
   Sample items: peg in pegboard move car on table
   block in bucket place ring on stacker
3. **3D-3D Matching (Identical Object Matching) SD**: "Put with same"
   Sample items: plates cups
   bowls spoons
4. **RC (Receptive Commands) SD**: "(Action") (eg "clap hands")
   Sample items: stomp feet stand up

clap hands raise arms

5. **RL (Receptive Labels) SD**: "Touch _____"
   Sample items: car hat
   book shoe
6. **VI (Verbal Imitation of sounds/words) SD**: "Say _____"
   Sample items: ah eee
   ooo mmm
7. **EL (Expressive Labels) SD**: "What is it?"
   Sample items: car hat
   book shoe

It is important to note that it was not possible to ascertain the specific number of trials per day for each skill, so trials to mastery could not be utilized in the analyses. Therefore, it is theoretically possible that a skill mastered in more days may have been implemented in fewer trials than a skill mastered in fewer days but with more trials per day. However, children receiving intervention with the Rutgers Autism Program model generally received instruction according to the following guidelines. Each program was implemented at least on time per session, with approximately 10 trials. Given that there were two sessions per day, it is estimated that each program had 20 trials per day as an average.

School Placement

Four years into treatment, information on school placement was obtained by parents and verified by school personnel. School placement was designated as regular education without individualized instruction in a typical classroom environment, or education requiring specialized and individualized instruction for some or all of the school day.

Results

Autism Severity

Prior to intervention, all 20 children scored in the severely autistic range on the CARS (*M* = 45.7, range 37.5 to 58, *SD* = 5.30). Post-intervention scores on the CARS reflected improvement for all children, but were consistent with differential outcomes (see Table 2). Nine participants scored clearly in the non-autistic range (i.e., below 30). Nine youngsters were in the mild-moderate range of autism (30 to 36), and two scored in the severe range (37 to 60). The mean post-intervention CARS score was 26.6 (range 15.5 to 43, *SD* = 8.60).

Table 2. CARS and Vineland Scores at the start of intervention and at 4-year follow-up.

Child	Original CARS	Current CARS	CARS change	Original Vineland	Current Vineland	Vineland change
1	43.5	31.5	-12	48	55	7
2	41	15.5	-25.5	52	113	61
3	41	15.5	-25.5	50	112	62
4	43	15.5	-27.5	50	160	110

5	53.5	33.5	-20	39	36	-3
6	37.5	30.5	-7	47	64	17
7	45.5	31.5	-14	39	68	29
8	43.5	25.5	-18	46	55	9
9	47.5	32.5	-15	48	46	-2
10	46.5	37.5	-9	45	34	-11
11	42	16.5	-25.5	55	115	60
12	47	19.5	-27.5	61	115	54
13	52	30.5	-21.5	63	51	-12
14	38.5	17	-21.5	63	103	40
15	58	43	-15	38	47	9
16	43	17	-26	49	108	59
17	41	21.5	-19.5	60	100	40
18	50	36	-14	43	39	-4
19	49	31.5	-17.5	57	51	-6
20	50.5	30	-20.5	44	49	5
Mean	45.68	26.58	-19.10	49.85	76.05	26.20
Standard Deviation	5.30	8.60	6.13	7.84	36.01	33.11

Adaptive Behavior

As shown in Table 2, the range of adaptive behavior composite standard scores on the Vineland Adaptive Behavior Scales (Sparrow, Balla, Cicchetti, 1984) prior to intervention was 38 to 63 (M = 49.85, SD = 7.84). This mean falls well below an average score of 100. In fact, the whole range falls more than two standard deviations below an average score on this measure (Sparrow, Balla, & Cicchetti, 1984). Post-intervention scores were more variable (M = 76.05, range 34-160, SD = 36.01). Eight children's scores were equal to or over 100. The remaining twelve children's scores break down as follows: two in the 60's, four in the 50's, three in the 40's, and three in the 30's.

School Placement

Four years into treatment, the children had been placed in a variety of educational settings (see Table 3). Information on school placement was obtained by parents and verified by school personnel. Seven of the 20 participants were enrolled full-time in regular education without support. Three additional children were enrolled full-time in regular education with minimal support (i.e., had some related services or a part-time instructional assistant). None of these children received any individual instruction in their classroom settings and received minimal help from the instructional assistants. Thus, 10 participants were receiving regular education services, participating in group instruction, and reportedly acquiring skills within a typical classroom environment.

Table 3. Placement after 4 years of Treatment.

Setting	# Students	Group
Full-time Regular Education - no support	7	1
Full-time Regular Education - minimal support	3	1
Full-time Regular Education - with 1:1 discrete trial	7	2

instruction		
Full-time Special Education	3	2

Group 1 - Regular Education with no or minimal support
Group 2 – Receiving systematic ABA instruction

The remaining 10 participants still required some individualized instruction. Seven of these 10 children were placed full-time in regular education, but received 1:1 intensive instruction from aides for part of the school day. All of these children also required full-time aides to successfully participate in group activities. The remaining three participants were placed in special education, receiving a combination of 1:1 intensive instruction and small group instruction.

Variability in Skill Acquisition

Table 4 shows the average number of days needed to master each of the 1st 5 items in each program across all children. There was considerable variability across children. Acquisition rates for all programs were combined for each child to come up with a summary acquisition rate. The range for this summary score was 1 to 27 days (M = 5.7, SD = 6.8), meaning that some children mastered each of the 1st five items in all seven programs in an average of 1 day each, with other children requiring as much as an average of 27 days to master each of the 1st five items across programs.

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Table 4. Average number of days to master each of the first 5 items

	Program						
Child	NVI	OM	RC	3D-3D	VI	RL	EL
1	1	1	2	2	3	3	2
2	1	1	2	1	1	1	1
3	1	1	1	1	1	1	1
4	1	1	1	1	2	1	2
5	3	2	2	3	4	3	4

6	1	2	2	1	2	1	2
7	1	1	1	1	1	1	1
8	4	2	4	2	5	3	2
9	3	2	5	2	3	2	2
10	2	1	1	1	1	2	1
11	4	2	4	2	2	2	1
12	8	4	14	5	2	10	3
13	5	2	3	2	4	3	2
14	25	13	24	7	51	10	13
15	30	17	31	6	50	27	
16	2	3	6	3	4	6	6
17	4	3	5	2	30	4	2
18	12	4	14	3	3	5	15
19	3	4	4	3	45	5	2
20	5	3	4	3	34	6	3

Correlation of acquisition rates with outcome variables

Childhood Autism Rating Scale (CARS). Correlation between skill acquisition measures and CARS scores are shown in Table 5. When averaged across all programs, the average rate for a child to learn each of the 1st five items was correlated with CARS scores at intake, $r(18) = .49$, $p \leq .025$ and 4 years into treatment, $r(18) = .46$, $p \leq .025$. Overall learning rate was not related to the amount of change in CARS scores from time 1 to time 2. In other words, children with higher CARS scores at the beginning and four years into treatment took longer to master items across all programs. The amount of improvement in CARS scores was not related to the speed of skill acquisition; therefore, children with both faster and slower learning rates showed comparable degrees of improvement relative to their initial score.

The rate of learning each of the 1st five items for some, but not all, of the seven individual programs was significantly correlated with children's CARS scores at the beginning of treatment and at 4 years, supporting the finding that children with lower CARS scores in the beginning of treatment learned a number of their programs faster and had lower CARS scores 4 years later. Receptive Commands, $r(18)=.42$, $p \leq .05$, 3D Matching, $r(18)=.58$, $p \leq .005$, Verbal Imitation, $r(18)=.49$, $p \leq .025$, and Receptive Labels, $r(18)=.45$, $p \leq .025$, were significantly related to the post-intervention CARS scores, with 3D Matching showing the strongest relationship and was also the only learning variable that was significantly related to the amount of change in CARS scores, $r(18)=.43$, $p \leq .05$. Children who mastered the 1st five items of 3D Matching more quickly showed lower CARS scores after treatment and greater degree of improvement than those children who took longer to master items in the same program. 3D Matching, $r(18)=.44$, $p \leq .025$, Verbal Imitation, $r(18)=.62$, $p \leq .005$, Receptive Labels, $r(18)=.39$, $p \leq .05$, and Expressive Labels, $r(18)=.38$, $p \leq .05$, were significantly related to CARS scores at the beginning of treatment, with Verbal Imitation having the strongest relationship. Children who took

longer to master Verbal Imitation items had higher CARS scores at the outset; however, learning rate on this program was not related to the amount of improvement in CARS scores.

Vineland Adaptive Behavior Scale (VABS). The overall average rate to master each of the 1st five items across all programs was not correlated with VABS scores at the beginning of treatment, but did show a significant relationship to follow-up VABS scores at 4 years, r(18)= -.48, p≤.025 (as shown in Table 6). Children who learned skills faster showed higher VABS scores post-treatment and showed more improvement in their VABS scores, r(18)= -.53, p≤ .025. Children who had slower learning rates did not improve as dramatically on the VABS.

Also shown in Table 6, rate of learning each of the 1st five items for all individual programs was related to the amount of change on the VABS and to the VABS scores at 4 years. Similarly to the CARS scores, 3D matching was the variable most strongly related to the amount of change, r(18)= -.62, p< .005 and the follow-up scores on the VABS r(18)= -.59, p≤ .005. Therefore, children who learned programs more quickly (particularly 3D matching) tended to have higher VABS scores 4 years into treatment and showed greater improvement, even though they did not have higher VABS scores in the beginning.

Placement. Of the pre-treatment and learning rate variables, initial CARS scores were the most strongly related to educational placement at 4 years, r(18)=.76, p<.005. Those children with lower CARS scores at the beginning of treatment were more likely to be placed in the least restrictive educational settings with less support. The initial VABS was also related to placement at 4 years, r(18)= .48, p≤.025, with children having higher initial VABS scores having less restrictive placements four years later. In addition, the children's rate of mastering each of the 1st five items of all programs overall and for each individual program was related to the placement information at 4 years (see Table 7).

Table 5. Pearson r correlation rate to master each of the 1st five items compared to CARS scores pre and post treatment.

Program	*CARS (4 years)*	*CARS (intake)*	*CARS Change*
All programs	.46*	.49*	ns
Receptive Commands	.42*	ns	ns
3D 3D Matching	.58****	.44**	.43*
Verbal Imitation	.49**	.62****	ns
Receptive Labels	.45**	.39*	ns
Nonverbal Imitation	ns	ns	ns
Object Manipulation	ns	ns	ns
Expressive Labels	ns	.38*	ns

* p≤.05
** p≤.025
****p≤.005

Table 6. Pearson r correlation rate to master each of the 1st five items compared to Vineland scores pre and post treatment.

Program	*Vineland (4 years)*	*Vineland (intake)*	*Vineland Change*
All Programs	-.49**	ns	-.54***
Receptive Commands	-.48**	ns	-.55***

3D 3D Matching	-.59****	ns	-.62****
Verbal Imitation	-.49**	ns	-.47**
Receptive Labels	-.46**	ns	-.51**
Nonverbal Imitation	-.39*	ns	-.46**
Object Manipulation	-.41*	ns	-.47**
Expressive Labels	-.38*	ns	-.48**

* p≤.05
** p≤.025
***p<.01
****p≤.005

Table 7. Pearson r correlation relationship between 4-year placement and pretreatment variables.

Intake CARS	*.76****
Intake Vineland	-.48**
Receptive Commands	.58****
3D 3D Matching	.63****
Verbal Imitation	.57****
Receptive Labels	.51**
Nonverbal Imitation	.49**
Object Manipulation	.51**
Expressive Labels	.45**

* p≤.05
** p≤.025
****p≤.005

Reliability

Inter-rater reliability data were available for the CARS and VABS for twelve of the twenty participants for the pre-treatment scores, and fourteen out of the twenty for post-treatment scores. The reliability data for the initial VABS and CARS scores are shown in Table 8. For the CARS, 4 out of the 12 pairs of total scores (33%) were identical. All 12 pairs of scores were within one point of each other. For the VABS, nearly all scores, 11 out of 12 (92%) were the same, and 12 pairs were within one point of each other.

Table 9 shows reliability data for scores on the follow-up administration of the CARS and scores on the follow-up administration of the VABS. For the CARS, 8 out of 14 pairs of total scores (57%) were equal to each other. All 14 pairs were within one point of each other. On the VABS scales, 7 out of 14 were exactly the same (50%), and 12 out of the 14 (86%) were within one point of each other. The remaining two pairs of scores were within two points of each other. The participants for whom reliability data were available were widely variable in characteristics and outcome (range of initial VABS scores of 38 to 60; range of follow-up VABS scores of 49 to 160). Four of the twelve participants scored equal to or above 100 on the second administration of the VABS.

The correlations for the reliability scores were all above .90. (Intake CARS, $r(10) = .995$, $p = .0001$; 4-year CARS, $r(12) = .999$, $p = .0001$; Intake VABS, $r(10) = .999$, $p = .0001$; 4-year VABS,

$r(12) = .999$, $p = .0001$). In addition, the means and standard deviations for the reliability data were closely matched (see Tables 8 and 9).

Table 8. Reliability data for initial scores (CARS and Vineland)

Child	Original CARS	Original CARS reliability	Original Vineland	Original Vineland reliability
1	43.5	n/a	48	N/a
2	41	n/a	52	N/a
3	41	n/a	50	N/a
4	43	43	50	50
5	53.5	n/a	39	N/a
6	37.5	37.5	47	47
7	45.5	46.5	39	40
8	43.5	43.5	46	46
9	47.5	48.5	48	48
10	46.5	46	45	45
11	42	42.5	55	55
12	47	46.5	61	61
13	52	52	63	63
14	38.5	n/a	63	N/a
15	58	59	38	38
16	43	43	49	49
17	41	41.5	60	60
18	50	n/a	43	N/a
19	49	n/a	57	N/a
20	50.5	n/a	44	N/a
Mean	45.68	45.79	49.85	50.17
Standard Deviation	5.30	5.56	7.84	8.05

Table 9. Reliability for follow-up scores (CARS and Vineland Scores)

Child	CARS at 4 years	4 year CARS reliability	Vineland at 4 years	4 year Vineland reliability
1	n/a	n/a	n/a	N/a
2	15.5	15.5	113	113
3	15.5	15.5	112	111
4	15.5	15.5	160	160
5	n/a	n/a	n/a	N/a
6	30.5	30	64	65
7	31.5	31.5	68	68
8	25.5	25	55	53
9	32.5	33	46	46
10	37.5	37.5	34	35

11	n/a	n/a	n/a	N/a
12	n/a	n/a	n/a	N/a
13	n/a	n/a	n/a	N/a
14	17	17	103	103
15	43	42.5	47	48
16	n/a	n/a	n/a	N/a
17	21.5	21	100	100
18	36	36	39	37
19	31.5	32	51	51
20	30	30	29	48
Mean	27.36	27.29	72.93	74.14
Standard Deviation	9.06	9.06	38.48	37.12

Discussion

The results of the present study indicate that the initial learning rates of children with autism were correlated with later learning and status after four years. Children who initially learned quickly continued to demonstrate rapid acquisition rates. Initial learning rates were also positively correlated with the child's scores on the CARS and VABS four years into treatment. This finding is consistent with the findings that initial skill acquisition in core curricular areas is related to outcome (Lovaas & Smith, 1988; Smith, Groen, & Wynn, 2000).

In addition to documenting the correlations between measures of initial learning and certain outcome measures, the results of the present study support the beneficial impact of intensive behavioral intervention for young children with autism (e.g., Anderson et al., 1987; Birnbrauer & Leach, 1993; Fenske et al., 1987; Harris et al., 1991; Lovaas, 1987; McEachin, Smith, & Lovaas, 1993; Maurice, 1993; Perry, Cohen, & DeCarlo, 1995). Our study lends support to the potential benefit of very intensive instruction, with every participant making substantial gains on standardized measures of outcome.

However, the present study showed highly variable outcomes for learners with autism exposed to intensive treatment. This is consistent with existing literature. While all children made extensive gains on measures of autism symptomatology, changes in adaptive behavior were more variable. While approximately half of the children were fully included in their educational placements, the remainder continued to require highly specialized instruction to learn skills.

The present study is limited in some critical ways. There was no control group or group receiving a different level of treatment. It therefore exists primarily as a clinical description of the effects of this model of intensive behavioral intervention.

Some important information regarding child and family characteristics was not collected. No information was gathered about family SES or the family environment. What can be said, however, is that this sample represents a self-selected group of families who specifically sought this form and intensity of intervention. In addition, the intervention model includes a significant parent training aspect, and promotes intensive parent involvement. The advocacy for ABA and level of involvement of the parents in this sample may be factors that are significantly related to the outcome for this group of children.

Also IQ data were absent. None of the children were tested by Rutgers Autism Program staff. In addition, IQ data from independent evaluations was not required. This is a serious omission, as a standardized measure of IQ would strengthen the study. Additionally, IQ may have demonstrated some prognostic value, as found by Harris and Handleman (2000).

A significant limitation is that there may be many other factors confounded with learning rate. For example, children varied widely in their responsiveness to selected rewards. Furthermore, it is impossible to capture the individualization of the programming efforts for each child, which may be of critical importance. A related possible source of impact is variability in the skill levels of teams. While training was equivalent, some teams were more enthusiastic, more acutely aware of nuances of instruction, or more thorough in their communication. This is a natural variable that was not possible to control, but which may have had an impact on the effectiveness of instruction.

An additional unanswered question is the extent to which early learning rates, in and of themselves, predict outcome. It is impossible to assess the unique predictive power of this variable in the present study, given the strong correlation with degree of autistic symptomatology. A future direction of research to address this issue would be to track the differential learning rates in a group of children with similar severity of autism as measured by instruments like the CARS or other diagnostic assessments.

Despite these limitations, none of the potential confounds can obscure the substantial link that we observed between initial performance and a child's status 4 years later. Further, the data are important as they add to the literature regarding the positive outcome of intensive behavioral intervention for young children with autism. All children made very significant gains over the course of the intervention period. However, a large number of children continued to need ongoing, specialized services. At times, the very substantial needs of this group are obscured by the focus on best outcome learners. As we continue to maximize the effectiveness of our instructional technology, we need to ensure that we address the needs of the entire spectrum of children with autism. We have a great deal to learn about how to best assist more impaired learners.

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